Appendix G - Current Position of Human Health Risks from Lead (Pb) Exposure in the United States

Eliza Lynch and Jo Cavanagh

Bioeconomy Science Institute: Manaaki Whenua Landcare Research

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1. Abstract

- Lead contamination in soil, air, and drinking water due to legacy lead-paint, legacy lead-gasoline, current and historic lead industrial emissions, and lead piping is a widespread problem across the United States, concentrated in urban areas, low-income communities, and communities of color.
- In efforts to address a widespread lead poisoning crisis, the federal government took legislative action in the 1970s to ban lead additives in paint, gasoline, and plumbing, and establish the Superfund cleanup program. Now, federal involvement is limited to action reports by the President's Task Force on Environmental Health Risks and Safety Risks to Children, EPA-directed cleanups, and CDC updated screening levels.
- The Center for Disease Control and Prevention (CDC) reports blood lead levels through the National Health and Nutrition Examination (NHANES) Survey and the Childhood Blood Lead Surveillance Program.
- The current childhood blood lead level (BLL) according to NHANES is an average of 0.83 μg/dL. While the BLL is below the current screening level (3.5 μg/dL), the average does not elucidate the disproportionate impact of lead contamination by geography, socio-economic status, and demographics.
- BLL monitoring in the United States is inconsistent; Medicaid and state law may require testing, but millions of children slip through the cracks due to a lack of awareness by health clinicians and families, inconsistencies in follow-up testing, and a lack of structural resources in rural and underserved communities.

2. Introduction

Lead contamination in soil, air, and water is a prolific and wicked problem in the United States that threatens both public and environmental health. Since the 1970s, lead management in the United States has been driven by the goal of protecting public health, especially for children. As scientific evidence has demonstrated the toxicity and health effects of lead, regulatory bodies in the United States have intervened to ban sources, remediate sites, and establish acceptable blood lead levels (BLL) and source screening levels (Frank et al., 2019). Monitoring programs at the federal, state, and local levels have also been established to better understand the distribution and magnitude of lead exposure and reduce lead poisoning in children. This report explores the current sources, exposure pathways, health risks, management, and monitoring of lead contamination in the United States to provide an international model for what can be done to address lead contamination in soil, air, and water. This report aims to provide insight into how one management style is working and what can be learned from it in New Zealand.

3. Lead Sources, Sinks, and Exposure Pathways

There are four primary sources of lead (Pb) in the United States (U.S.): (1) Historical lead-based paint, (2) historical lead-based gasoline, (3) historical and current industrial emissions, and (4) lead pipes. These sources enter the environment through wet and dry deposition, ending up in three primary sinks: (1) soil and sediments, (2) air, and (3) water. The significance and impact of these sources and sinks varies by region and neighborhood.

3.1 Soil Contamination

Lead-based paint, lead gasoline, and lead industrial emissions are the primary sources of soil and dust contamination.

Lead-based paint was used in the United States until 1978, but its improper removal and general deterioration have led to continuous dust and soil deposition (Rouillon et al., 2017). Contamination from this source is most prevalent in older homes and homes in the Northeast and Midwest regions, the older parts of the country, though it is estimated that 38 million housing units (40% of all homes) contain some lead-based paint (American Healthy Homes Survey, 2021; Filippelli et al., 2024).

Historical lead-based gasoline was phased out in 1996, but it continues to affect communities near airports--lead can still be a fuel additive in airplanes-- and in areas with high vehicle traffic (Hamel et al., 2017). This source contributes less to soil contamination than lead paint.

Industrial emissions such as the mining and smelting of Pb ore, the manufacturing of Pb-containing products, and secondary production, such as lead battery recycling, also lead to Pb contamination (Toxicological Profiling for Lead, 2020). This source of contamination is most concentrated in areas with a current or historical industrial presence, such as former mining districts in the Tri-State District (*Tri-State Mining District - Cherokee County*, 2017).

Lead is deposited from these sources into soil and sediments through the deterioration and flaking of lead-based paint chips, and from the atmospheric deposition of road dust and industrial emissions (Toxicological Profiling for Lead, 2020). It is estimated that almost one quarter of households in the United States—almost 30 million—exceeds the 200 ppm screening level for lead in soil (Filippelli et al., 2024). Soil contamination concentrations distributed across the United States can be seen below (Figure 1).

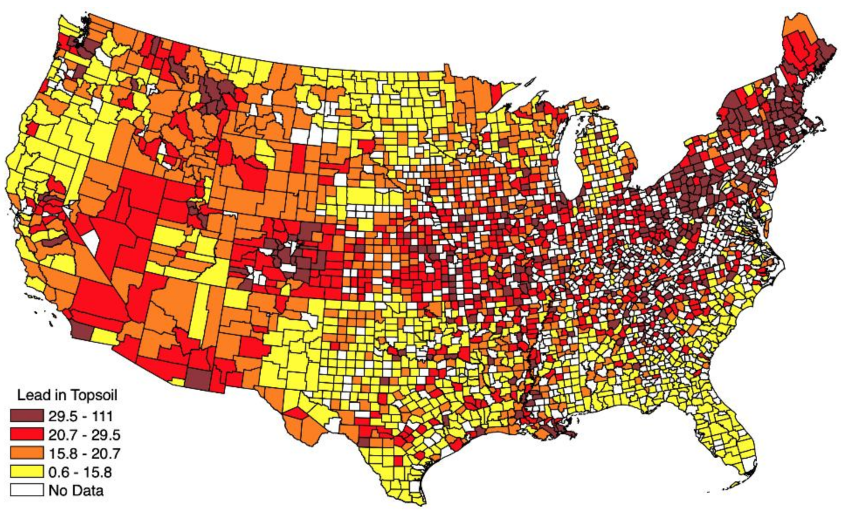

Figure 1: *Lead concentrations (mg/kg) in topsoil, a depth of 0-5 cm. Data is taken from the U.S. Geological Survey collected from 2004 to 2010 (Barsotti, 2019).*

Concentrations are not evenly distributed within the home or by neighborhood. At the household level, concentrations are often elevated at the dripline of homes and near roadways (Dietrich, Rader, & Filippelli, 2023). At the neighborhood level, lead contamination is highest in urban areas (Levin et al., 2021), in low-income areas (<$35,000 USD), and in communities of color (Oliva and Som, 2022). This trend is based in a legacy of environmental racism in the United States (Miranda et al., 2023).

The main exposure pathways to lead from soil and dust are ingestion and inhalation (Toxicological Profiling for Lead, 2020). People, and especially children, living in areas contaminated with one or more sources of lead may ingest contaminated soil or dust via hand-to-mouth contact (Toxicological Profiling for Lead, 2020). For instance, soils can stick to hands and urban garden produce, resulting in particle ingestion (Huang et al., 2024). Contaminated soil and dust may also be inhaled through the nose or mouth if less than 10μm. Even finer particles (<2.5μm) can be inhaled and become embedded into the deepest part of the lungs (Menegaki et al., 2024).

3.2 Air Contamination

Another key sink for lead contamination is the air. Pb can enter the air via the remobilization of legacy soil sources, or through direct industrial and vehicular emissions.

Pb strongly adsorbs soil, and with a long residence time—from decades in topsoil (5cm) to centuries in deeper soils (20cm) (Obeng-Gyasi et al., 2021) — historical sources (lead paint and gasoline) in the soil can be remobilized, remaining a threat long after deposition (Malone and Shakya, 2024). Studies of Pb resuspension in Birmingham, AL, Chicago, IL, Detroit, MI, and Pittsburgh, PA have linked the resuspension of contaminated sources with seasonal fluxes in elevated BLL in children (Laidlaw et al., 2012). The possibility that clean soils could be re-contaminated via wind and precipitation demands more research, for corroborating findings could prompt a need for the reconsideration of Pb remediation strategies (Paltseva et al., 2022).

Industrial emissions from metal processing and from vehicles have also been key air pollutants. Fortunately, lead pollution in the air decreased by 99.6% from 1970 to 2011 with the phase out of leaded gasoline (Toxicological Profiling for Lead, 2020).

3.3 Water Contamination

Water is primarily contaminated with Pb due to lead pipes. Lead is found in an estimated nine percent of the United States' national water pipe infrastructure. The state of Florida and what is called the "Rust Belt" of the Midwest contain the highest percentage of lead pipes (Figure 2) (Gilligan, 2023).

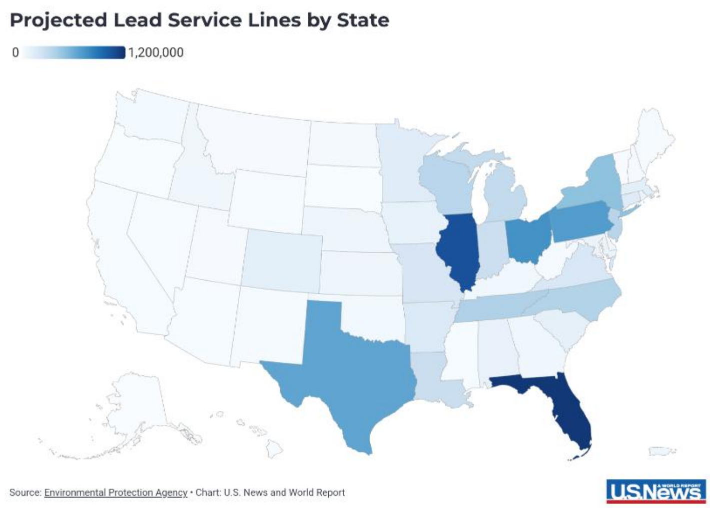

Figure 2: *Lead Pipe Infrastructure Distribution in the United States. Data is taken from the EPA (Gilligan, 2023).*

Pb leaches from lead pipes into the drinking water if it is too corrosive (Toxicological Profiling for Lead, 2020). Lead can also get into the water through industrial releases into surface water or soil/sediment runoff (Toxicological Profiling for Lead, 2020), but the corrosion of lead water pipes is the most significant pathway.

One infamous example was the Flint Water Crisis in Flint, Michigan in 2014 where 140,000 people were exposed to lead contaminants in their drinking water (Ruckart et al., 2019). This contamination was detected when citizens started to complain about the taste and smell of their water. Though ten years ago, this crisis has become a focal point for the Environmental Justice movement in the United States and has led citizens and politicians alike to prioritize water policy, especially around water accessibility, affordability, and the racial disparities in water politics (Van Deelen, 2024). This crisis is one of the most high-profile cases, but it is only one of many similar environmental injustices surrounding lead contamination in water across the United States.

3.4 Other Sources, Sinks, and Exposure Pathways

Other less significant exposure pathways in the United States include the ingestion of contaminated water or food, dermal contact with cosmetics and other consumer products, and occupational exposure (Toxicological Profiling for Lead, 2020). The U.S Food and Drug Administration (FDA) sets and enforces lead limits in bottled drinking water and provides industrial guidelines on lead in specific types of food and consumer products (e.g., baby food and cosmetics). The U.S Occupational Safety and Health Administration (OSHA) establishes acceptable blood lead levels for different occupational exposure pathways.

4. Management of Lead in the United States

4.1 A Timeline of Lead Management in the United States

Lead management in the United States, for the purpose of protecting public health, especially for children, has a long history in the United States. Lead poisoning was first diagnosed by U.S. medical authorities in 1887. Throughout the 1920s, 30s, and 40s, medical professionals and scientists began to identify lead, specifically both lead-based paint and lead-based gasoline, as causes of physical and neurological disorders (Kitman, 2000). By 1967 — the lead poisoning peak in the United States — almost 15% of children had a BLL greater than 50 µg/dL, (Allwood et al., 2022), and almost no children had BLL less than 5 µg/dL (Figure 3). An EPA study in 2000 estimated that 5,000 Americans died annually from lead-related heart disease before interventions were taken (Kitman, 2000).

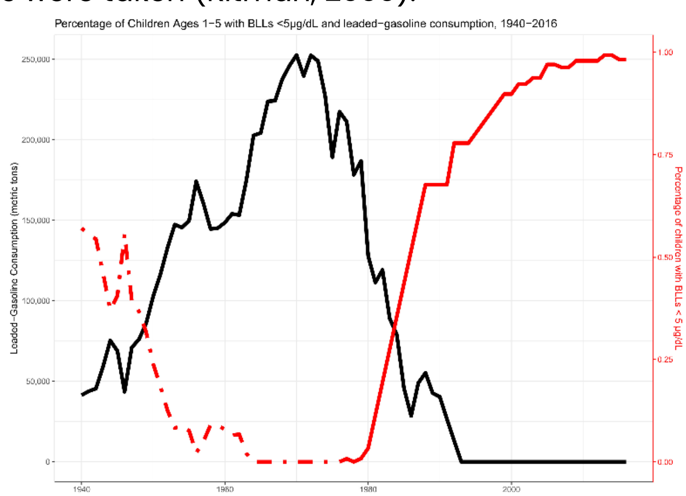

Figure 3: *Leaded-Gasoline Consumption and Percentage of Children with BLLs <5μg/L by year in the United States. The BLL data is from NHANES 1976-2016, and the Leaded-Gasoline Consumption data is from Bureau of Mines Minerals Yearbook (McFarland et al., 2022).*

The 1970s marked the beginning of U.S. federal intervention (Figure 4). *The Clean Air Act* was passed in 1970, followed by the *Lead-Based Paint Poisoning Prevention Act (1971)*. *The Lead-Based Paint Poisoning Prevention Act (1971)* mandated the Department of Housing and Urban Development (HUD) to reduce lead hazards "as far as practicable" in public housing and any private housing built before 1978 that were receiving federal funds (Yen, 2013). It also allowed federal funds to be used for local lead detection and abatement projects, and most notably, banned lead-based paint in residential structures built with any federal assistance (which went into effect in 1978) (Yen, 2013). This Act was expanded by the *Lead-Based Paint Prevention Act (also known as the Lead Title X Act)* in 1992, which authorized federal grants for the reduction of lead-based paint hazards in privately owned housing and housing that do not receive federal assistance (Yen, 2013). HUD still sets and enforces standards regarding lead-based paints in federally funded housing.

To address existing contamination, the *Comprehensive Environmental Response, Compensation, and Liability Act (Superfund Act)* was passed in 1980 to clean up uncontrolled and abandoned waste sites. It also gave the EPA the power to seek out parties responsible for the cleanup (US EPA, 2018, August).

Lead in plumbing was phased out in 1986 (Lanphear et al., 2024). This phase-out was strengthened by the *Lead Contamination Control Act (1998)* that banned the manufacturing of lead-lined water coolers and ordered the repair or removal of existing ones. This Act also authorized grants for local and regional BLL screening programs for high-risk children (Office of Water, 1989). Lead gasoline was fully phased out in 1995 (Toxicological Profile for Lead, 2020).

Since this point, routes of management of lead in soil have primarily focused on minimizing exposure from legacy sources by (1) updating screening levels, (2) facilitating the remediation of Superfund Sites, and (3) writing Action Plans and reports meant to guide federal agency action. There has been no lead legislation passed by Congress since 1998.

4.1.1 Updating Screening Levels

In 1994, the Environmental Protection Agency (EPA) established the first lead soil hazard standard: 400 µg/g for bare soil in play areas and 1,200 µg/g for bare soil in the remainder of the yard. In 2001, the EPA established dust hazard screening levels: 40 µg/f^2 for floors and 250 µg/f^2 for windowsills (Lanphear et al., 2024). The current guidelines are listed below (Table 1).

Table 1: *Current Screening Levels for Lead in the United States.*

Sink / Source	Regulatory Body	Standard		Citation
AIR	EPA NAAQS	0.15 µg/m^3		(US EPA, 2019)
DRINKING WATER	EPA Action Level	15 µg/L		(US EPA, 2009)
	FDA Allowable Level in Bottled Water	5 µg/L		(FDA, 2019)
SOIL	EPA Screening Level	200 ug/g		(US EPA, 2024, Oct)
DUST	EPA Hazard Screening Standards AND HUD Action Levels	Floors	5ug/ft^2	(US EPA, 2024, Oct)
		Windowsills	40ug/f^2	
		Window Troughs	100 ug/ft^2	

In 2024, the EPA lowered its screening level for lead-contaminated residential soils from 400 µg/g to 200 µg/g. Further, if there is more than one source present (e.g., water or air in addition to soil), the EPA recommends an even lower screening value of 100 µg/g (US EPA, 2024, Jan). There is no protocol for how these sources are identified, but rather these numbers serve as general guidance for the scientific and public health communities.

This change in screening level was motivated by the need to align the screening level with advances in scientific knowledge surrounding lead exposure. The screening level had not been updated since 1994, and so the 2024 update aimed to incorporate the past thirty years of research that had highlighted that lead exposure was more dangerous to child health than originally thought (US EPA, 2024, April). The new screening levels were generated using the IEUBK model (Leed, 2024). In this model, the goal is to limit the probability of child BLL exceeding 5 μg/dL, or exceeding 3.5 μg/dL for residential sites where more than one source is identified. Sources include water service pipes, lead-based paint, or areas where lead-in-air concentrations exceed the NAAQS limit (0.15 $\mu g/m^{3)}$.

While this update marks progress in aligning federal screening levels with the scientific consensus that there are no safe levels of Pb in the blood (CDC, 2024b), it is important to note that screening levels are not cleanup levels (Office of Land and Emergency Management, 2021). The cleanup process is detailed below.

4.1.2 Facilitating Clean Up

The EPA is also responsible for facilitating the cleanup of Superfund sites. Citizens, States, Tribes, or other Environmental Programs can notify the EPA about hazardous waste activity or a potential release. Following notification, the EPA follows a four-step process to determine if and how a site should be remediated (Office of Land and Emergency Management, 2021).

(1) *Prioritize*: Screening levels signal if a site qualifies for further investigation. If there is an exceedance above the soil screening guidelines, the citizen or environmental program may report to the EPA. The EPA then completes a Pre-CERCLA assessment. This assessment considers any existing information about a site (e.g. reported data) to see if it warrants further investigation. The EPA must prioritize sites due to the high volume of contaminated sites. Prioritized sites are often where children live or play (US EPA, 2015).

(2) *Evaluate*: If the site is prioritized after the Pre-CERLA assessment, the site undergoes a preliminary assessment and potentially a site inspection, which consider risk factors, community input, exposure pathways, and background lead levels. Following these evaluations, each site is given a Hazard Ranking System (HRS) score (Figure 4).

(3) *Decide*: If the HRS score is above 28.50, the site is placed on the National Priorities List (NPL). These sites qualify for short-term or long-term federal cleanup programs (US EPA, 2021). If sites do not qualify for the NPL, they can be referred to other cleanup programs at the state or municipal level (US EPA, 2015).

(4) *Act*: The EPA or responsible parties will implement necessary cleanup programs if the site is on the NPL. These steps may include health education, establishing protective barriers, or property cleanup. If a site is not on the NPL, similar cleanup programs may be available at the state or municipal level (US EPA, 2015).

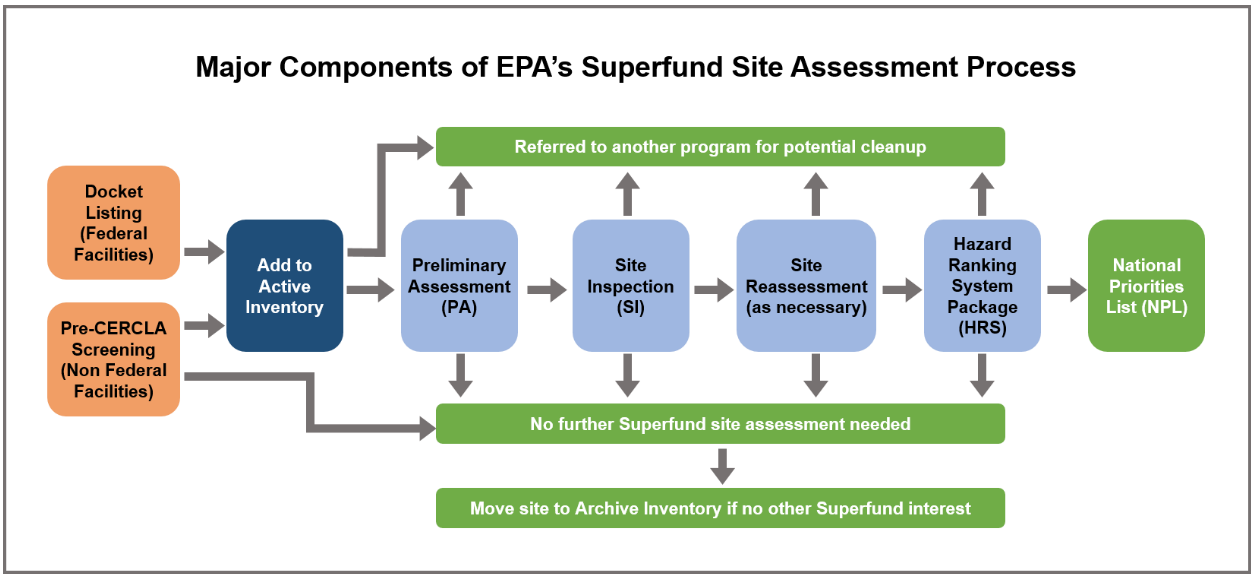

Figure 4: *Main Components of EPA's Superfund Site Assessment Process (US EPA, 2015).*

There are currently 1,340 sites on the National Priorities List in which over 1,200 have reported lead contamination (US EPA, 2015).

4.1.3 Federal Action Plans and Reports

Though no legislation has been passed since 1995, Executive Orders and Federal Action Plans/Reports have been written about minimizing lead health effects and exposure. Executive Order 13045 (1997) under President Clinton established the President's Task Force on Environmental Health Risks and Safety Risks to Children. The

Task Force comprises 17 federal departments and offices and is co-chaired by the Administrator of the EPA and the Secretary of the Department of Health and Human Services (President's Task Force on Environmental Health Risks and Safety Risks to Children, 2019). This task force has been active in lead exposure reduction efforts for the past thirty years.

Some notable outputs by this task force include: (1) The report on *Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards* in 2000, and (2) The Report on *Key Federal Programs to Reduce Childhood Lead Exposures and Eliminate Associated Health Impacts* in 2016. Most recently, the task force established the "2018 Federal Lead Action Plan to Reduce Childhood Lead Exposure." This action plan is meant to help federal agencies collaborate strategically to reduce children's exposure to lead and improve their health. The Action Plan's main goals include:

(1) Reduce Children's Exposure to Lead Sources

(2) Identify Lead-Exposed Children and Improve Their Health Outcomes

(3) Communicate More Effectively with Stakeholders

(4) Support and Conduct Critical Research to Inform Efforts to Reduce Lead Exposures and Related Health Risks.

(5) Implement Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), which orders federal agencies to incorporate Environmental Justice initiatives into their missions.

These two past reports, as well as the current action plan, are meant to help federal agencies prioritize their efforts and budget to minimize lead exposure for children and monitor progress. Realistically, all recommended actions are subject to budgetary constraints, interagency processes, stakeholder input, and Congressional and Administrative priorities, so there is no assurance that any action items are implemented (President's Task Force on Environmental Health Risks and Safety Risks to Children, 2019). However, one success of this task force was the reduction of the EPA soil screening guidelines from 400 to 200 ug/g.

4.2 Blood Lead Levels in the United States

4.2.1 CDC Blood Lead Level Monitoring

The U.S Center for Disease Control and Prevention (CDC) is the key governing body that provides funding, conducts research, and establishes Blood Lead Reference Values for childhood blood lead level prevention. The CDC runs two key BLL monitoring programs: (1) the National Health and Nutrition Examination Survey (NHANES) and (2) the Childhood Blood Lead Surveillance Program.

In 1956, the *National Health Survey Act* was passed, which authorized a continuing survey to provide statistical data on the amount, distribution, and effects of illness and disability in the United States (CDC, 2024e). In accordance with this act, the first National Health Examination Survey began in 1960. This survey was later combined with the National Nutritional Surveillance System in 1971 to become the first NHANES Survey. The survey still runs today, with data last published in 2018.

The second CDC monitoring program, the Childhood Blood Lead Surveillance program, began in 1995 as a part of the Childhood Lead Poisoning Prevention Program, which was started by the *Lead-Based Paint Poisoning Prevention Act of 1971*. This program allows the CDC to monitor BLLs that are reported by state and local childhood lead poisoning prevention programs through the Healthy Homes and Lead Poisoning Surveillance System. Interventions for BLL exceedances reported through this program are at the discretion of the health care provider. The CDC does not intervene with the data that is reported through this system.

4.2.2 CDC Screening Guidelines

Overtime, as scientific evidence and NHANES survey results have demonstrated the toxicity and health effects of lead, and Pb-detecting technology has advanced, the CDC has intervened to limit sources and establish acceptable blood lead levels (BLL) (Frank et al., 2019).

In the 1960s, the BLL screening guidelines stood at 60 ug/dL. Since then, the BLL screening guideline in the United States has been steadily decreasing (Figure 4). The BLL reference value is updated every four years by the CDC and is based on the 97.5th percentile BLL distribution from children surveyed in the latest two National Health and Nutrition Examination Surveys (CDC, 2024b). This value, currently 3.5 ug/dL, is used to identify children with “higher than most” BLL. This value is not a “safe value," as the CDC has stated that there is no safe BLL for children. Instead, this BLRV is a statistically-derived number to help identify children who need higher-priority intervention.

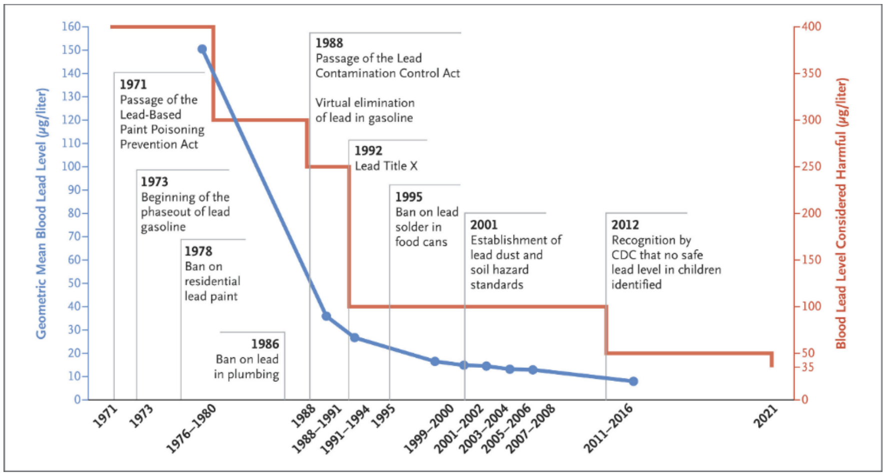

Figure 5: *A History of Lead Poisoning, New England Journal of Medicine (Lanphear et al., 2024). In 2018, the Geometric Mean Value BLL in children aged 1 to 5 was 0.83 µg/dL (CDC, 2024d).*

In addition to advancements in scientific research, public health initiatives and programs at the state and federal scale, such as National Lead Poisoning Prevention Week (US EPA, 2017) and Chicago's Lead Poisoning Prevention Program (CDC, 2024a), have increased public awareness and involvement that has pushed increased research and the continued reduction of the BLL screening guideline. There is also a history of activism and organizing that has challenged lead industries and encouraged elected officials to take action to protect their constituency (*This Lead Is Killing Us*, 2024).

5. Monitoring Programs and Intervention

5.1 State and Federally Mandated Testing

State and federal blood lead level testing in the United States is piecemeal, though there are some programs in place (Figure 5). There is no universal requirement for blood lead level testing, despite the continuous push for universal screening by some local and state public health officials and other nonprofit initiatives (Allwood et al., 2022). There is also no consistent monitoring of historical or emerging contamination in drinking water or soil (Brooks et al., 2019). Some researchers believe that vested interests such as housing, mining, and industrial groups may be impacting program support (Allwood et al., 2022).

There are also calls by the American Academy of Pediatrics (AAP) and other public health organizations for a shift towards primary prevention rather than secondary prevention, a focus on the removal of sources rather than solely BLL testing (Allwood et al., 2022). Despite these efforts, primary prevention is not prioritized in the current "Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Effects" (President's Task Force on Environmental Health Risks and Safety Risks to Children, 2019). Current mandated BLL testing in the United States falls under Medicaid testing, state testing, or self-initiated testing.

Figure 6: *Long-term lead action timeline in the United States. Blue = key legislation, green = monitoring programs, purple = change in screening levels, orange = action plans.*

5.1.1 Mandated Medicaid Testing

Fingerpick/capillary blood lead testing is currently covered and required by Medicaid, the United States federal health insurance for low-income community members. It has been mandated since 1989. Around 50% of U.S. Children–37 million children–use Medicaid. This testing is supposed to occur for children on Medicaid at both 12 and 24 months (*Children at Risk: Gaps in State Lead Screening Policies,* 2017). If the testing result exceeds the CDC reference value (3.5μg/dL), then the child is tested again using the intravenous technique. If this second test shows concurring results, under the Early and Periodic Screening, Diagnostic, and Treatment (EPSDT) program, the child is entitled to follow-up services and treatment (*Blood Lead Screening Tests*, 2018). Unfortunately, many children may not receive this follow-up testing and treatment (*For Medicaid-Enrolled Children Diagnosed with Lead Toxicity in Five States*, 2022), and more consequently, it is estimated that only 38% of the children who should be receiving tests through Medicaid receive testing in the first place (*Children at Risk: Gaps in State Lead Screening Policies,* 2017). This disparity is especially prominent in smaller rural communities (Brooks et al., 2019).

5.1.2 State Testing

Each state has its own requirements (or lack thereof) for child blood lead testing. 11 states have universally mandated blood lead testing, often requiring blood lead testing to enroll in public school. Massachusetts (MA) is one of the strongest examples. MA mandates universal testing at age three, testing for children living in high-risk areas at age four, and additional testing when warranted by specific risk factors. It also has a reporting requirement for all kids under six, and a mandated test to begin kindergarten (*Children at Risk: Gaps in State Lead Screening Policies,* 2017). Health care providers are usually responsible for completing the testing, but some states put the responsibility on the parent or on the state health center. Some states also mandated insurance coverage for BLL tests. If this is not a requirement, and if the child is not on Medicaid, then the cost is out of pocket. BLL tests tend to cost from $10 to $45 USD. The cost is reduced if states use “Point-of-care" blood lead testing machines. Idaho and New Jersey both provide testing machines to clinics for free (*Children at Risk: Gaps in State Lead Screening Policies,* 2017).

Eight states have targeted testing instead of universal testing. Children who meet certain criteria (e.g., living in housing built before 1950, living near a smelter, or residing in a designated elevated risk zip code) are mandated for testing, while others who do not meet the criteria are exempt. Though this system sounds ideal, targeted testing often depends on a parent filling out a questionnaire in a doctor's office. This system is unreliable because it requires the medical practitioner to know about and be involved with the BLL state testing system and the parent to accurately and honestly answer the questions (Sobin et al., 2023).

The majority of states (27) have written guidelines, often conveyed verbally through the doctor or on the state website, but no mandated testing. Five states--Arkansas, Montana, North Dakota, South Dakota, and Wyoming--have no guidelines at all (*Children at Risk: Gaps in State Lead Screening Policies,* 2017).

If there are exceedances, some states have recommendations on their website or verbally by the healthcare provider, but they are not uniform (*Children at Risk: Gaps in State Lead Screening Policies,* 2017).

5.1.3 Self-Initiated Testing

There are local nonprofits that conduct free blood, soil, and water testing (usually with some eligibility requirements), but if someone is concerned about Pb, the formal process involves hiring an EPA-approved environmental consultant to perform a risk assessment. Some nonprofits, such as the Improving Kids' Environment Program in Indiana (*Lead Abatement Program - Improving Kids' Environment*, 2025), cover the cost of consultation and offer remediation assistance if there are exceedances, but otherwise, the cost for consultation is out of pocket for the family.

5.2 National Health and Nutrition Examination Survey

The CDC directs the National Center for Environment and Health (NCEH), which conducts the National Health and Nutrition Examination Surveys (NHANES) once every two years. The National Examination Survey (which later became NHANES) began in 1956 when the *National Health Survey Act* was passed, authorizing a continuing survey to provide statistical data on the amount, distribution, and effects of illness and disability in the United States (CDC, 2024e). NHANES collects a wide range of comprehensive health information from diet to health behaviors, and specifically collects BLL data to better understand lead exposure and hotspots, inform public health interventions, and reduce lead poisoning.

The survey still runs today, with data last published in 2018. NHANES data includes personal interviews, physical examination, and laboratory tests for 10,000 people a year (CDC, 2024d). These people are randomly selected, and participation is voluntary. The data is meant to be nationally representative of BLL in the United States. NHANES was halted in 2020 due to COVID-19, and has not released BLL data since 2018 (CDC, 2024d). In 2018, the average BLL in children aged 1 to 5 was 0.83 µg/dL (CDC, 2024d). The average BLL for adults was 0.920 µg/dL (Toxicological Profiling for Lead, 2020).

If testing shows BLL exceedances, the CDC has set guidelines for the adult guardian to take depending on the severity of the BLL (3.5-19µg/dL, 20-44µg/dL, >45µg/dL). These steps may include additional testing, reporting the results to the local or state health department, arranging for environmental investigation of home sources, and consultation with the child's pediatrician about nutrition, diet, and next steps (e.g., abdominal surveys for paint chips or hospital admittance). The Department of Housing and Urban Development (HUD) may also be alerted if the levels are above 19 µg/dL, though these requirements vary by state (Centers for Disease Control and Prevention, 2024).

5.3 CDC Childhood Blood Lead Surveillance Program

The CDC also monitors BLL through the Childhood Blood Lead Surveillance program (Allwood et al., 2022). This program began in 1995 as a part of the Childhood Lead Poisoning Prevention Program, which was started by the *Lead-Based Paint Poisoning Prevention Act of 1971*. This program allows the CDC to monitor BLLs reported by state and local childhood lead poisoning prevention programs through the Healthy Homes and Lead Poisoning Surveillance System, which is online.

The CDC receives around 3 million tests a year, which are then summarized by state, year, and blood lead level (CDC, 2024c). These tests are initiated by healthcare providers, so the program is not representative of the entire U.S. population. Instead, it is meant to monitor children who are likely candidates for elevated BLL. This process may leave children to slip through the cracks if they do not see a regular healthcare provider or visit a provider who does not initiate such tests. There is no formal protocol for increasing awareness about this program among healthcare providers. When a test is given, intervention is left to the healthcare provider's discretion if BLL is above 3.5 μg/dL (CDC, 2024c).

5.4 American Healthy Homes Survey

The American Healthy Homes Survey I and II, conducted in 2018-2019 and 2020-2021, measured levels of lead, lead-based paint (LBP) hazards, pesticides, formaldehyde, and mold in homes nationwide. It was conducted through collaboration between the EPA and HUD to increase understanding of demographics and environmental parameters relating to residential housing. It was also conducted to compare lead and arsenic levels with the National Survey of Lead and Allergens in Housing (NSLAH) that had been conducted in 1998-1999. Approximately 1,100 homes were tested (dust samples and soil samples) that were meant to be nationally representative of the United States (*American Healthy Homes Survey II Lead Findings*, 2021). This is not a recurring survey like the other monitoring programs.

The results showed that 34.6 million homes (29.4%) of homes tested have lead-based paint somewhere in the building, 89% of which were built before 1978. This report did not contain any evidence that sample exceedances of EPA/HUD dust and soil screening levels triggered any intervention by HUD or the EPA in the tested homes (*American Healthy Homes Survey II Lead Findings*, 2021).

5.5 Academic Research

Recent research surrounding human risks from lead exposure is very prevalent and active in the United States due to the magnitude and scope of the problem. Following the search requirements: ((TS=(Lead)) AND ALL=("Pb")) AND ALL=("United States"), 818 results were found on the Web of Science that were conducted between 2023-2025. Many studies draw conclusions based on both the NHANES surveys and the American Healthy Homes Surveys by investigating the relationship between Pb exposure and different health conditions (see Hu et al., 2023, Ruiz et al., 2025, and Sowers et al., 2024). Other academic studies (not related to EPA site investigations) focus on specific contaminated sites, such as Superfund sites; neither of these categories of studies is included in this list. There are also national, regional, or city surveys that focus on lead exposure and health risks using non-NHANES or the

American Healthy Homes Survey data. Table 2 contains a sample of 485 papers found in Web of Science that met the search requirements: (((TS=("lead")) AND ALL=("Pb")) AND ALL=("United States")) NOT AB=("NHANES" AND "National Health and Nutrition Examination Survey" AND "American Healthy Homes") and were conducted in 2023-2025.

Table 2: *Recent national and regional lead surveys in the United States, 2023-2025.*

Title	Study Location	Year	Reference
Characterizing lead exposure in households that depend on private wells for drinking water	National	2023	(Alde, et al., 2023)
The lead and copper rule: Limitations and lessons learned from Newark, New Jersey	Newark, New Jersey	2023	(Stratton et al., 2023)
Pesticide, allergen, PCB, and lead measurements in childcare centers located on tribal lands in the Pacific Northwest, United States.	Washington, Oregon, and Idaho	2024	(Tulve et al., 2024)
Assessing Unequal Airborne Exposure to Lead Associated with Race in the USA	National	2023	(Laidlaw et al., 2023)
Lead Levels in Species from Market Basket and Home Lead Investigation Samples in North Carolina	North Carolina	2023	(Angelon-Gaetz, 2023)
Occurrence and Spatial Distribution of Lead, Arsenic, Cadmium, and Uranium in Soils of Southern Louisiana	Southern Louisiana (Baton Rouge to New Orleans)	2023	(Nyachotti et al., 2023)
A Public Health-Community Partnership to Address Lead Poisoning in King County, Washington	King County, Washington	2025	(Acosta et al., 2025)
Airborne Lead Exposure and Childhood Cognition: The Environmental Influences on	National	2024	(Gatzke-Kopp et al., 2024)

Child Health Outcomes (ECHO) Cohort (2003-2022)			
Geospatial Assessment of Racial/Ethnic Composition, Social Vulnerability, and Lead Water Service Lines in New York City	New York City	2023	(Nigra et al., 2023)
Childhood Lead Exposure Linked to Apple Cinnamon Fruit Puree Pouches – North Caroline, June 2023--January 2024	North Carolina	2024	(Napier et al., 2024)

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